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Seismological Laboratory, Caltech - MC 252-21, 1200 E California Blvd, Pasadena, CA 91125, USA

## Education

- Ph.D. Geophysics, California Institute of Technology** **2009**  
(Expected)
- DISSERTATION:* Mechanical Models for Interpreting Interseismic Geodetic Data in Subduction Zones
- FOCUS:* Semi-Analytical & Finite Element Modeling, Inverse theory, GPS data analysis
- COMMITTEE:* Profs. Mark Simons (adviser), Jean Philippe Avouac, Robert Clayton, Mike Gurnis
- M.S. Geophysics, California Institute of Technology** **2005**
- PROPOSITION 1:* A Suction Mechanism for Iron Entrainment into the Lower Mantle,  
Prof. David Stevenson (Published, GRL)
- PROPOSITION 2:* Mechanical Modeling of Interseismic Deformation in Subduction Zones  
Prof. Mark Simons (In Review, GJI)
- COURSEWORK:* Geophysics, Mechanics, Finite Element Modeling (GPA: 4.0)
- M.S. Geological Sciences, University of Kentucky** **2003**
- THESIS:* A Nonlinear, 2D, Asperity-Scale Frictional Melting Model.
- COMMITTEE:* Profs. Kieran O'Hara (Geo), Jim McDonough (Mech. Engg), Shelley Kenner (Geo)
- COURSEWORK:* Geology, Applied Math, Numerical Algorithms & Techniques (GPA: 4.0)
- M.S. Engineering, University of Cincinnati** **1997**
- THESIS:* Modeling urban ozone dynamics in the Cincinnati area. (Environmental Engg.)
- COMMITTEE:* Profs. Pratim Biswas (adviser), Shafiq Islam (co-adviser), Jim Uber
- COURSEWORK:* Dynamical Systems, Applied Math, Air-Pollution Transport & Control (GPA: 3.7)
- B. Tech Mechanical Engineering, Indian Institute of Technology (IIT) - Bombay** **1994**
- MAJOR:* Thermal and Fluid Sciences & Engineering (GPA: 3.3; Major GPA: 3.5)
- THESIS:* Experimental and Theoretical Study of Gas-Liquid Slug Flow in Horizontal Channels
- COMMITTEE:* Profs. Kannan Iyer (adviser), J.B. Doshi, R. P. Vedula

## Professional Experience

- Environmental Engineer, Science Applications International Corp. (SAIC)** **1997-2002**
- RESPONSIBILITIES:* Air-quality modeling; Compliance site-inspections; Modeling multi-pathway pollutant transport and risk assessments; Tested/evaluated environmental/geological software (e.g., [EQuIS](#)).

## Awards and Honors

- Gutenberg Fellowship** (2003) Department-wide competitive award given to an outstanding incoming PhD student  
Seismological Laboratory, Caltech
- Commonwealth Research Award** (2002) University-wide competitive award by the Dean of Academic Research, for exceptional research presented at a major national conference.  
Univ. of Kentucky
- Pirtle Fellowship** (2001-02) Department-wide competitive award given to an outstanding incoming graduate student as additional supplementary stipend.  
Dept. of Geosciences, Univ. of Kentucky
- Graduate Research Assistantship** (2001-03) Under Prof. Kieran O'Hara, for numerical investigation of the energetics of frictional melting in fault zones.  
Dept. of Geosciences, Univ. of Kentucky
- University Summer Research Fellowship** (1996) University of Cincinnati – A university-wide competitive award given to outstanding independent research problems.  
(1996) Univ. of Cincinnati

**99.4<sup>th</sup> percentile,**  
Indian Institute of Technology – Joint  
Entrance Examination, India: 1990

Ranked in the top 0.6% out of roughly 100,000 pre-screened candidates in the national level test in Math, Physics, and Chemistry, for admission to the prestigious Indian Institutes of Technology (IIT).

### Research Goals

I want to model lithospheric deformation at plate margins to infer the structure and rheology of the crust and upper mantle over timescales ranging from a thousand to few million years. Specifically, I want to understand how individual earthquakes result in the accumulation of permanent topography at plate boundary zones, and whether such topography can help us better understand seismic hazard. I ultimately want to understand the feedback between orogeny and surface processes (erosion, sedimentation), as well as that between plates boundaries and the uppermost-mantle for both convergent and divergent plate margins. Towards this end, I want to use geodetic, seismic, and geologic data (structural geology, geomorphology, and thermochronology) to constrain rheological and structural parameters using numerical models of mechanical deformation. I am also interested in incorporating the effects of poroelasticity, and thermal advection/diffusion into current mechanical models of crustal deformation, since these processes significantly affect the strength of the crust and its heterogeneous structure. I also want to understand the energy efficiency of subduction, and its implications for the rheology of the upper and lower mantle. This is linked to the bigger problem of long-term cooling of the Earth's interior. I am therefore interested in the physical mechanisms that control the structure and composition of the core-mantle boundary (CMB) region, as well as the shape, and structure of the D" layer.

### Publications

- Kanda, R. V. S.**, E. A. Hetland, and M. Simons (2009), Can Interseismic Geodetic Observations Resolve Persistent Rupture Asperities? (In Prep)
- Kanda, R. V. S.**, and M. Simons (2009), An Elastic Plate Model for Interseismic Deformation in Subduction Zones, *J. Geophys. Res.* (In Press)
- Thomas, W. A., **R. V. S. Kanda**, K. D. O'Hara, D. M. Surlis (2008), Thermal Footprint of an Eroded Thrust Sheet in the Southern Appalachian Thrust Belt, Alabama, USA, *Geosphere*, 4(5), p. 814-818, doi 10.1130/GES00168.1.
- Kanda, R. V. S.**, and D. J. Stevenson (2006), Suction mechanism for iron entrainment into the lower mantle, *Geophys. Res. Lett.*, 33, L02310, doi:10.1029/2005GL025009.

### Meeting Abstracts

- Kanda, R. V. S.**, E. A. Hetland, M. Simons, S. E. Owen, and F. W. Webb (2008), Can Interseismic Geodetic Observations Resolve Persistent Rupture Asperities? A study of the Japan trench off Tohoku. *EOS Trans AGU*, 89(53), Fall Meet. Suppl., Abstract T23A-1989.
- Hetland, E. A., M. Simons, E. M. Dunham, and **R. V. S. Kanda** (2008), Interseismic Deformation and the Mechanical Behavior of Megathrusts: Transient Postseismic Creep, Stress Shadows, and Megathrust Rheology, *EOS Trans AGU*, 89(53), Fall Meet. Suppl., Abstract T12A-04.
- Kanda, R. V. S.** and M. Simons (2006), Simple Elastic Dislocation Models for Interpreting Interseismic Deformation in Subduction Zones, *EOS Trans AGU*, 87(52), Fall Meet. Suppl., Abstract T12C-02.
- K. D. O'Hara, **R. V. S. Kanda**, and Thomas, W. A. (2006), Thermal Footprint of an Eroded Thrust Sheet in the Black Warrior Basin, Alabama, USA, *GSA Abstracts with Programs*, Vol. 38, No. 3, Abstract 101868.
- Kanda, R. V. S.** and D. J. Stevenson (2004), A suction mechanism for iron entrainment from the outer core into the lower mantle, *EOS Trans AGU*, 85(47), Fall Meet. Suppl., Abstract MR43A-0880.
- Kanda, R. V. S.**, and K. O'Hara (2002), Nonlinear Modeling of Frictional Melting at Asperity Tips, *EOS Trans AGU*, 83(47), Fall Meet. Suppl., Abstract S52B-1078.
- Kanda, R. V. S.**, and K. O'Hara (2002), An asperity scale frictional melting model, *GSA Abstracts with Programs*, Vol. 34, No. 6, Abstract 42522.
- Kanda, R. V. S.** (2001), A Spherical Two Dimensional Asperity Scale Frictional Melting Model, *EOS Trans AGU*, 82(47), Fall Meet. Suppl., Abstract S22B-0647.

### Programming, and Computer Skills

<b>Numerical Methods:</b>	Numerical Algorithms, Finite Element & Finite Difference Methods, Inverse Theory (Optimization, Bayesian Methods)
<b>Programming Languages:</b>	Fortran 95/90/77, Python/Numpy/Scipy, C, MPI, HTML
<b>Software Applications:</b>	Matlab, GMT, SAC, ArcGIS
<b>Operating Systems:</b>	Unix/Linux/OS-X Shell scripting, OS-X & Windows XP administration

### Professional Field Trips & Related Skills

<b>Neotectonics and Quaternary Geology of the Tien Shan Foreland Basin, Xinjiang, China</b> (2-week Field Trip: Profs. Jean Philippe Avouac, and Rob Clayton): Participants helped conduct a seismic survey at the Anjihai anticline (northern Tien Shan), and visited several areas in the foreland basins north & south of the Tien-Shan. Designed and built the <a href="#">official field-trip web page</a> .	<b>Summer, 2006</b>
<b>Geophysical Survey of southern Chalfant Valley, Eastern California</b> (1-week Field Class): <b>Teaching Asst.,</b> Ge 111a/b, Field Geophysics (Profs. Rob Clayton, Joann Stock, Mark Simons) Supervised and assisted students in carrying out GPS, gravity, & magnetic surveys.	<b>Summer, 2005</b>
<b>Geophysical Survey of Deep-Springs Valley, Eastern California</b> (1-week Field Class): Ge 111a/b, Field Geophysics (Profs. Rob Clayton, Joann Sotck, Mark Simons) Multi-method surveys were performed to infer the geologic structure beneath this valley, using GPS, seismic, gravity, magnetics, GPR, & resistivity.	<b>Summer, 2004</b>
<b>Outdoor skills:</b> Orienteering, backpacking, endurance bicycling (road) & running, swimming, SCUBA diving, sea-kayaking.	

### Teaching Experience & Professional Service

<b>Graduate Teaching Assistant, Seismological Laboratory, Caltech:</b>	
<b>Field Geophysics</b> (Prof. Rob Clayton): Developed Matlab GUI for a Seismic refraction code.	<b>2005</b>
<b>Field Geophysics</b> (Profs. Rob Clayton, Mark Simons, Joann Stock): GPS, gravity, magnetic, seismic, and resistivity field surveys in Chalfant Valley, eastern California.	<b>2006</b>
<b>Geodynamics</b> (Prof. Mike Gurnis): Taught 2 classes, clarified & graded homework	<b>2007</b>
<b>Inverse Theory</b> (Prof. Malcolm Sambridge, visiting from ANU): Clarified & graded homework	<b>2007</b>
<b>Graduate Teaching Assistant, Dept. of Civil &amp; Environmental Engg., Univ of Cincinnati:</b>	
<b>Aquatic Chemistry:</b> Clarified & graded homework	<b>1996</b>
<b>Fluid Mechanics</b> - Hydraulic systems (Prof Shafiq Islam): Taught classes, set exam questions, clarified & graded homework	<b>1996</b>
<b>Peer Tutor, Univ. of Cincinnati Educational Services:</b>	
<b>Mathematics &amp; Physics</b> (Undergraduate) for Science majors. Coached and mentored undergraduate students as part of a university-wide learning assistance program for 1 yr.	<b>1994-95</b>
<b>National Social Service (NSS) Tutor IIT-Bombay (India):</b>	
<b>Mathematics</b> (Primary/Middle-school). Child literacy program volunteer for the National Social Service (NSS) corps. Mentored young kids from poor neighborhoods for 1 yr.	<b>1990-91</b>
<b>Manuscript Reviews (Journals)</b>	<b>EPS</b>

## Research Experience

**1. Kanda, R. V. S.,** E. A. Hetland, M. Simons, S. E. Owen, and F. W. Webb (2009), **Can Interseismic Geodetic Observations Resolve Persistent Rupture Asperities? A study of the Japan trench off Tohoku.** [In Prep]

**Ph.D.  
Dissertation  
Research  
(Caltech)**

Published earthquake source inversions based on seismological data for the Tohoku region of Japan suggest that some large earthquakes ( $M > 7$ ) have repeatedly ruptured the same region of the fault (i.e., asperities), while others have ruptured closely clustered asperities. In contrast, inversions of geodetic data from interseismic periods produce models that are locked over more spatially extensive regions. These broad and smooth regions may be a consequence of lack of model resolution and a resulting need for regularization when using onshore geodetic data. Here, we test the hypothesis that mechanical coupling on inferred asperities alone is sufficient to explain available geodetic observations – i.e., asperities persist across earthquake cycles, and that these data do not require slip along additional regions on the megathrust. To address this question, we use a 3-D mechanical model of stress-dependent interseismic creep along the megathrust, that is consistent with a given frictional rheology and the known spatio-temporal distribution of large earthquakes. These mechanical models also predict a relatively smooth and long wavelength surface velocity field late in the seismic cycle. We are testing if this “physical” smoothing preserves any signature of the original asperities, in contrast to the artificial smoothing produced by model regularization. (In Preparation)

**2. Kanda, R. V. S.,** and M. Simons (2009), **A Plate Model for Interseismic Deformation in Subduction Zones,** *J. Geophys. Res.*, In Press.

Geodetic observations of interseismic surface deformation near subduction zones are frequently interpreted using simple elastic dislocation models. In this theoretical study, we develop a kinematically more intuitive elastic dislocation model - the elastic subducting plate model (ESPM) - having only two more degrees of freedom than the well established backslip model (BSM): an elastic plate thickness and the fraction of flexural stresses due to bending at the trench that are released continuously. The ESPM (i) predicts no net long-term vertical offset between the subducting and over-riding plates, and (ii) predicts the correct amplitude and direction of motion for the former. We show that the ESPM reduces to the BSM (a) in the limiting case of zero plate thickness, (b) for a plate of finite thickness, if the stresses associated with bending at the trench are released continuously and completely in the shallow parts of the subduction zone, or (c) much deeper ( $> 100$  km). However, if at least part of the bending stresses are released episodically in the shallow parts of the subduction zone (via seismic or aseismic events), then the predicted surface velocities of these two models can differ significantly within a distance of several locking depths from the trench. An important consequence of (a) is that when applying the BSM to a non-planar megathrust, backslip must be assigned onto the actual non-planar interface, instead of to its tangent plane at the bottom of the locked zone. (In Press)

**3. Kanda, R. V. S.,** and D. J. Stevenson (2006), **Suction mechanism for iron entrainment into the lower mantle,** *Geophys. Res. Lett.*, 33, L02310, doi:10.1029/2005GL025009.

Perturbations in the Earth's rotation rate at decadal time periods strongly favor the existence of dissipative coupling at the Core–Mantle Boundary (CMB). Here, we explored the plausibility of maintaining a conducting layer on the mantle-side of the CMB, which can couple the outer core and mantle through Lorentz torques. We propose a suction mechanism that maintains a porous medium on the mantle side of the CMB, with the interconnected pore-space partly or entirely filled with liquid iron up to a thickness of  $\sim 100$  km. This layer is solid in regions of mantle downwelling. Infiltration of liquid iron occurs by percolation, but is inhibited by the rate of viscous dilation of the solid mantle. Our model enables core-mantle material exchange, and maintains a thin conducting layer that has seismic detection potential. Our model is only marginally satisfactory in explaining the inferred CMB coupling. (Published)

4. Thomas, W. A., **R. V. S. Kanda**, K. D. O'Hara, D. M. Surles (2008), **Thermal Footprint of an Eroded Thrust Sheet in the Southern Appalachian Thrust Belt, Alabama, USA**, *Geosphere*, 4(5), p. 814-818, doi 10.1130/GES00168.1.

**Independent Research**  
(U. Kentucky)

The Jones Valley thrust fault in the southern Appalachian thrust belt in Alabama is exposed along a northwest-directed, large-scale frontal ramp, with the leading part of the thrust sheet having been eroded. Previously published and newly collected vitrinite reflectance data from Pennsylvanian coal beds document a distinct, northeast-trending, elongate, ovoid-shaped thermal anomaly northwest of the trace of the Jones Valley fault. My contribution to this paper was the 3D analytical model for heat conduction after “instantaneous” emplacement of a rectangular thrust sheet, that was designed to test whether the documented thermal anomaly may reflect a former thrust sheet cover. Owing to the 3D nature of the solution, the geothermal gradient reaches a steady state faster than the 1 D model. The original geotherm is never fully re-established even for long times because of lateral cooling in the hanging wall, resulting in less heating of the footwall. The thickness and extent of the thrust sheet from the thermal model are consistent with both the vitrinite reflectance data as well as the balanced and restored cross sections of the thrust sheet.

*(Published)*

#### 5. A 2D Nonlinear Asperity Scale Frictional Melting Model.

Research Advisers: Prof. Kiren O'Hara (Geol), and Prof. Jim McDonough (Mech. Engg.)

**MS Thesis**  
(U. Kentucky)

This study examines the influence of asperity-scale fault dynamics on asperity temperature distribution, and therefore, the potential for frictional melting to occur at asperity tips. The model assumes that quartz asperities, which rarely appear in pseudotachylytes (PT, or frictional melts), might be the heat source responsible for softer minerals like feldspar and mica to melt. The model assumes adiabatic slip, and asperities whose thermal properties are strongly temperature dependent. The main thrust of this work was to develop and thoroughly validate a 2D implicit finite-difference code for solving the non-linear heat conduction equation with arbitrary nonlinear, time-dependent boundary conditions (non-moving boundaries), for both Cartesian, and generalized Elliptical geometries (e.g., spherical, cylindrical, other simply connected regions). For ease of extension to 3D, the parallelizable Douglas- Gunn finite difference scheme was used along with a Newton-Kantorovich iterative solver. Preliminary results indicate that (a) peak temperatures are attained slightly after asperity tip separation, (b) melting is localized, and much of the melt in PT may actually come from asperity tips, and (c) non-linear thermal diffusivity plays a significant role in localizing melting, especially for quartz asperities, as hypothesized above. Solving more realistic geologic problems (e.g., to incorporate asperity distributions, and sections of fault surface, as well as fault gouge) will require further enhancement of the code.

*(In Prep,  
pending code  
upgrade)*

#### 6. Urban Ozone Dynamics: An analysis of the Cincinnati Airshed.

Research Advisers: Prof. Pratim Biswas, and Prof. Shafiq Islam (both from Civil & Environ. Engg.)

**M.S. Thesis**  
(U. Cincinnati)

Applied EPA's Urban Airshed Model (UAM-IV) – a 3D finite-difference photochemical grid model – to identify the controls for urban ozone concentrations in the Cincinnati airshed. The model calculates the concentrations of both inert and chemically reactive pollutants by simulating the physical and chemical processes in the atmosphere affecting pollutants. We tested model sensitivity to pollutant source distributions and meteorological parameters. Principal-component analysis of modeled ozone distributions were used to determine the primary factors influencing ozone concentrations, and suggested potential control measures.

#### 7. Experimental and Theoretical Modeling of Gas-Liquid Slug Flow in Horizontal Channels.

Adviser: Prof. Kannan Iyer (Mechanical Engg.)

**B.Tech Thesis**  
(IIT-Bombay,  
India)

Modeled gas-liquid slug flow, slug frequency, and gas-entrainment in horizontal circular and coaxial channels. Our goal was to understand the conditions favorable to the slug flow regime, which reduces the efficiency of heat-exchangers in power plants. Conductance probes were fabricated, calibrated and tested, then placed in a horizontal test-section to detect the onset of slug flow. Conductance data were recorded by a digital oscilloscope, and analyzed to map out the pressure-temperature-velocity regime under which this flow persists.